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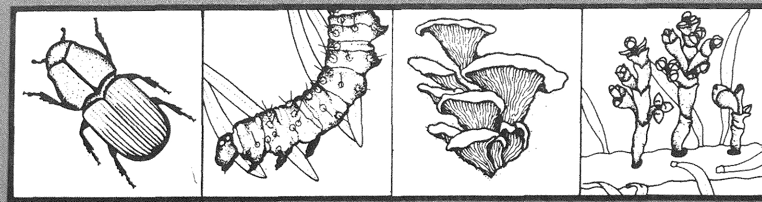
Forest Pest Management



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EFFICACY OF DOUGLAS-FIR BEETLE TREE BAITS IN CONTAINING OUTBREAK POPULATIONS OF DOUGLAS-FIR BEETLES IN NORTH IDAHO

Kenneth E. Gibson
and
Robert D. Oakes

ABSTRACT

The effectiveness of Douglas-fir beetle (DFB) tree baits in concentrating Douglas-fir beetle populations was tested on the Fernan Ranger District (RD), Idaho Panhandle National Forests (IPNF) in 1989. Six Douglas-fir stands of similar composition and infestation intensity were selected. Three were baited with semiochemical tree baits, three were not. Following beetle flight, baited stands averaged 81 newly attacked trees while unbaited stands averaged 7 new attacks. This project provides data suggesting a "bait and cut" strategy for reducing losses to DFB is both ecologically and economically feasible.

INTRODUCTION

The Douglas-fir beetle, Dendroctonus pseudotsugae Hopkins, is by far the most destructive bark beetle attacking Douglas-fir throughout its range. Often found in high "endemic" conditions where it is associated with root disease in densely-stocked, large-diameter, old-growth Douglas-fir stands, beetles occasionally erupt to outbreak proportions. Almost always, DFB epidemics follow some type of stand disturbance such as blowdown, winter damage or, less commonly, logging activity (Furniss, et al 1979). Recorded outbreaks have also been associated with severe defoliation and periods of prolonged drought (Furniss and Orr 1978).

In the Northern Region, DFB populations expanded for the third consecutive year in 1988 (Gibson and Oakes 1989). Taking advantage of abnormally-dry weather, beetles infested nearly 24,000 acres in North Idaho. In 1987, slightly more than 15,000 acres had been affected in the same area. In excess of 56,000 beetle-killed trees, representing 19.3 million board feet volume, were recorded during annual aerial surveys in 1988 (Gibson and Oakes 1989).

In 1989, infested areas declined to 16,600 acres. In addition, significantly fewer trees were attacked in 1989--in response to improved precipitation throughout much of the affected area and the possibility that many overwintering beetles were killed by extremely cold temperatures during February 1989. Still, higher-than-normal beetle populations existed in many old-growth Douglas-fir stands in northern Idaho and western Montana.

United States Department of Agriculture | Forest Service | **Northern Region** | P.O. Box 7669 Missoula, Montana 59807

As early as 1961, Rudinsky (1961) proposed that unique sets of conditions, relative to host and bark beetle interactions, were necessary for bark beetle outbreaks to occur. Later work by Rudinsky, and others, identified a complex of pheromones--produced by DFB and dependent upon host volatiles--which help regulate beetle populations (Rudinsky 1968, 1969, 1973; Rudinsky, et al 1974a, 1974b). By the mid- to late-1980's, "tree baits," which use both artificially-synthesized mimics of beetle-produced pheromones and host terpenes to manipulate bark beetle populations, were commercially available (Phero Tech 1985). These semiochemical ("message-bearing" chemicals) dispensers have shown promise, when used in conjunction with logging, of reducing outbreak intensity in threatened or infested stands.

Semiochemical chemicals tree baits have been developed for mountain pine beetle (D. ponderosae Hopkins), spruce beetle (D. rufipennis [Kirby]), western pine beetle (D. brevicomis LeConte), and DFB--as well as other primary and secondary bark beetles. Their use, as an additional tool in the silvicultural process, can be effective in containing beetle populations until infested stands are removed. While total beetle-caused mortality may not be greatly reduced, infestation spread, and subsequent threats to adjacent stands, may be significantly lessened (Borden, et al 1984).

This strategy, best documented for containing and curtailing mountain pine beetle populations (Borden, et al 1983, 1986) should work equally well with other bark beetle species. DFB populations in 1989 (Gibson and Oakes 1987, 1988) provided an opportunity for evaluating a "bait and cut" strategy aimed at reducing Douglas-fir mortality attributable to DFB. We believed attractant tree baits were sufficiently effective that we could increase the number of attacked trees in infested groups--relative to nearby, infested, but unbaited stands. If that were the case, we should be able to exhibit the effectiveness of that strategy in preventing beetle population spread from infested areas.

METHODS

In April 1989, we selected six predominantly Douglas-fir stands on the Fernan RD, IPNF. All were similarly infested by DFB--averaging 7.1 trees per acre currently infested (range 4.9 to 10.2 trees per acre). Stand size was likewise similar--ranging from 6 to 16 acres (table 1). All six stands were located in the vicinity of Mason Saddle, north of Fourth of July Pass, east of Coeur d'Alene. Baited stands were within one-half mile of each other. Unbaited (check) stands were as far as two miles from baited stands (figure 1).

We were unable to randomly select stands to be baited. Rather, we were constrained to bait stands scheduled for removal. Because of the similarity of stands, however, we do not believe that resulted in a negative impact on project outcome. Three stands were baited, three were not. Bait deployment was that suggested by the manufacturer: one bait per tree at 50-meter (2.5 chain) intervals, hung on the north side of the tree and above understory vegetation (Phero Tech 1989). A tree bait is a small (approx. 3.75 x 6.75 inches) brown plastic bag containing vials, or impregnated polymer chips, of synthetically-produced beetle pheromones or host terpenes. In the case of DFB, the baits contain frontalin (pheromone produced by female DFB), alpha-pinene and camphene (host volatiles). Baits are attached to the tree with a hand stapler.

Stands were baited on April 26, prior to beetle flight. In the largest block (#1), we baited 25 trees. In block #2, 20 trees were baited. In the smaller block (#3), baits were attached to 13 trees.

During the first week of August, following attack period of the beetle, we evaluated treatment effectiveness. At the same time, we collected comprehensive stand data. We conducted a 100 percent cruise of each of the six areas. On that survey, all Douglas-fir, over 5 inches dbh (diameter at breast height) were tallied according to diameter and damage code. Damage codes used were: not attacked, attacked in 1989, attacked in 1988, or older dead. Attacked trees were further categorized as "successful" or "unsuccessful." Successfully attacked trees were those in which brood was produced and developed, and which trees subsequently died. Infrequently, a tree was attacked successfully on only one side. Those we recorded as strip attacks.

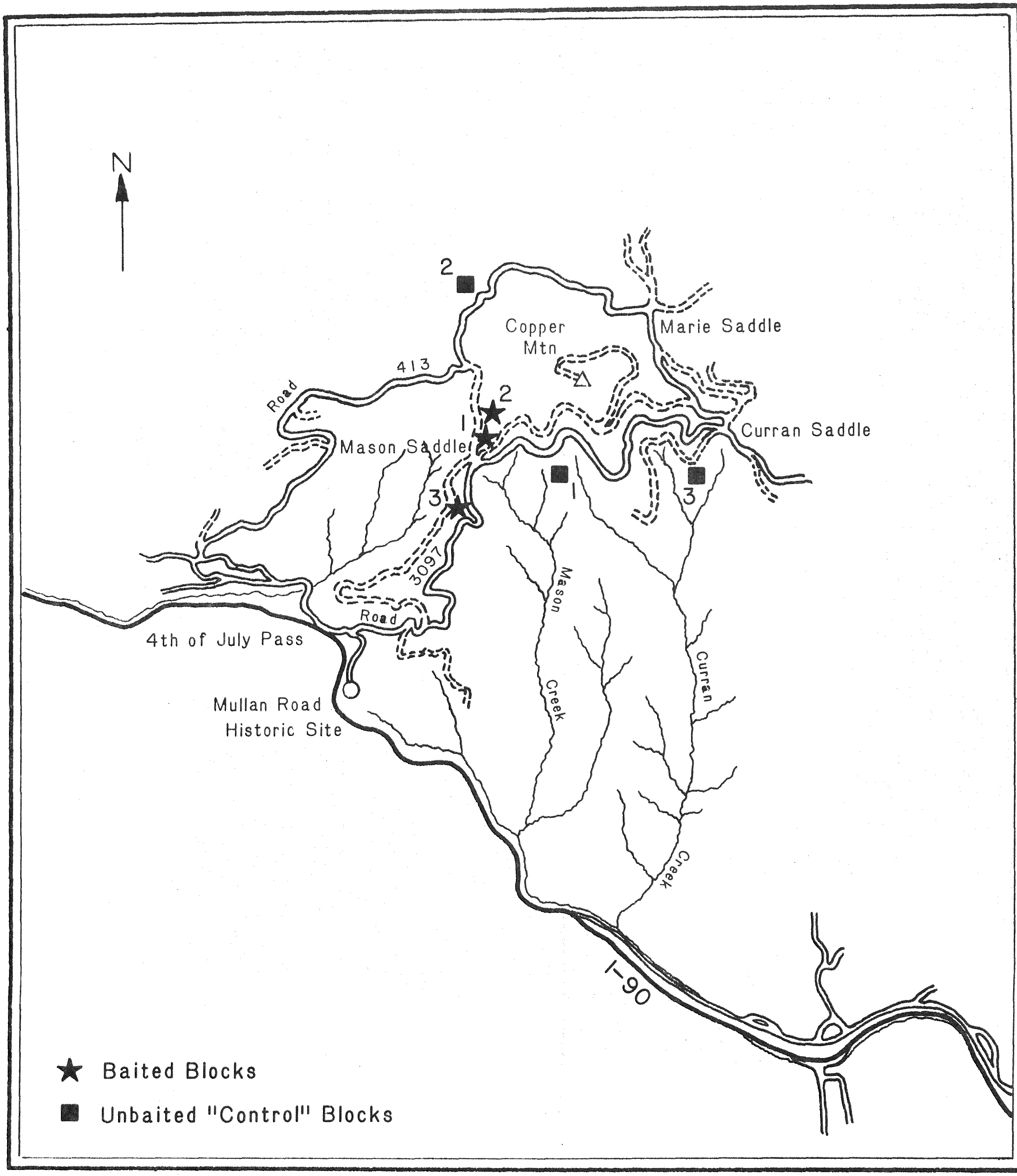

Figure 1. "Bait & Cut" Project Area, Fernan RD, IPNF, ID, 1989

Trees apparently successfully attacked--determined from external characteristics of boring dust and/or pitch streaming--were sampled to ascertain brood presence and condition, and to calculate parent:brood ratios. Ten successfully-attacked trees in each area (where there were that many) were sampled. Brood sampling consisted of removing a one-foot square piece of bark from the uphill side of the tree at a height of about twelve feet. Tree-climbing ladders, a bow saw, and hand axe were used to reach and remove bark samples at that height.

Gallery "starts"--used to determine number of attacking (parent) beetles--were counted either from inner side of removed bark, or from outer surface of sapwood from which bark had been removed. After recording gallery starts, developing beetle brood within the bark sample was tallied. Brood was recorded according to developmental stage and as alive or dead. It was necessary to extricate brood from within the inner bark with a sheath knife.

Finally, three variable-radius plots (BAF 20) were established at 3- to 5-chain intervals on a transect running diagonally through the stand. On those plots, all "in" trees, equal to or greater than 5 inches dbh, wererecorded according to species and diameter. Douglas-fir were additionally given a damage code--as previously described. Dead non-DFB hosts were not tallied. At each plot center, regeneration data were collected from a 1/300th-acre, fixed-radius plot.

Stand data were analyzed using the computer program INDIDS (Bousfield 1980). Treatment effectiveness data were subjected to a standard Student-t test to determine significant difference, or lack thereof, between treatment means.

RESULTS

Post beetle-flight evaluations of treated blocks revealed the effectiveness of the tree baits in either containing or attracting flying DFB. In baited block #1, 19 of the 25 baited trees were attacked. In block #2, 16 of 20 were attacked, and in #3, 10 of 13. In many cases, at least one other nearby tree was also attacked. Numerous trees were not attacked by a sufficient number of beetles to kill the tree (unsuccessful attacks). That, however, was more a result of declining beetle populations than of bait ineffectiveness (table 1).

In total, in the baited blocks, there was a much higher attack in 1989 than recorded in the unbaited blocks. Even though not all baited trees were attacked, 64 trees in block #1 were successfully attacked. Another 42 trees were partially attacked. We believe that, too, is a reflection of declining beetle numbers. While trees unsuccessfully attacked remained alive--and for the most part did not contribute to beetle flights in 1990--we included them in calculating the 1989:1988 attack ratio because those trees were affected by beetles taking part in the 1989 flight. At the same time, in some of the blocks, because of the difficulty in distinguishing between year of attack, we included questionable trees in the column (table 1) titled "88 + Old Attack." In block #1, 79 trees were recorded in that category. In calculating attack ratio, we summed "89 Suc Attack" and "89 Un Attack" and divided by "88 + Old Attack." For block #1, that ratio was 1.34:1.

Comparable figures for block #2 were: Ten trees successfully attacked, 36 unsuccessfully attacked, and 40 attacked in 1988. Attack ratio was 1.15:1. In block #3, 30 trees were successfully attacked and 61 unsuccessfully attacked. Seventy-four had been attacked in 1988. An attack ratio of 1.23:1 was the result.

Table 1. Post Treatment Results, "Bait & Cut" Pilot Project
Fernan RD, IPNF, ID, 1989

Area	Acres	No. Baits	DF + 10"	Bait Attack	89 Suc Attack	89 Un Attack	% 89 Attack	Br/Pa Ratio	88+Old Attack	Ratio 89:88
B-1	16	25	644	19	64	42	16.5	0.46:1	79	1.34:1
B-2	12	20	543	16	10	36	8.5	0.36:1	40	1.15:1
B-3	10	13	472	10	30	61	19.3	1.80:1	74	1.23:1
C-1	10	--	220	--	3	2	2.3	*	72	0.07:1
C-2	6	--	70	--	8	3	15.7	0.13:1	61	0.18:1
C-3	6	--	185	--	3	3	3.2	0.09:1	67	0.09:1

Note: DF = 10" = Green Douglas-fir in stand equal to or greater than 10" dbh
Bait Attack = Number of baited trees attacked
89 Suc Attack = Number of Douglas-fir successfully attacked in 1989
89 Un Attack = Number of Douglas-fir unsuccessfully attacked in 1989
% 89 Attack = Percent of green Douglas-fir in stand attacked in 1989
Br/Pa Ratio = Brood to parent ratio in successfully attacked trees
88 + Old Attack = Douglas-fir killed by DFB, predominantly in 1988
B-1..., C-1... baited blocks 1,2,3 and check blocks 1,2,3 respectively
* No live brood found in samples

While 1988 attack figures in the untreated blocks were similar to those in the treated blocks, there were far fewer 1989 attacks, and as a result, much smaller attack ratios. Because of the proximity of check block #1 to treatment block #1 (approx. 5/8 air mile, figure 1), it is conceivable that beetles were attracted away from the unbaited block into the baited one. The other two check blocks, however, were sufficiently far from the baited blocks that we doubt that phenomenon occurred. Rather, we believe the natural dispersal of beetles and declining populations resulted in fewer trees being attacked in those blocks in 1989. Beetle attack data collected in the three check areas, shown in table 1, show attack ratios of 0.07:1, 0.18:1, and 0.09:1 for blocks 1, 2, and 3 respectively.

Statistical analyses performed on these data likewise demonstrate treatment effectiveness. Following beetle flight, baited blocks contained an average 81 ± 25.5 new attacks. Unbaited blocks showed an average 7 ± 2.6 new attacks (table 2). Treatment mean was significantly different from control mean at the $p<0.0025$ level when subjected to standard Student-t test.

Table 2. Mean Number New Attacks in Baited and Unbaited Areas
"Bait & Cut" Pilot Project
Fernan RD, IPNF, ID, 1989

	Mean	Std. Error	Blocks	t Test p
Baited	81.0	25.5	3	<0.0025
Unbaited	7.3	2.6	3	

Though our block design and analysis procedures did not permit definitive statements regarding the distance over which baits will attract beetles, observations suggest one-quarter to one-half mile may be a reasonable assumption. Personal experience with mountain pine beetle tree baits (unpublished data) has resulted in a conclusion that tree bait effectiveness is dependent upon beetle population. Where populations are abnormally high, tree baits do not compete as effectively with natural pheromone sources. As a result, distance over which baits attract beetles is diminished. Conversely, when beetle populations are low, baits appear to attract beetles from a much greater distance--perhaps in excess of one mile.

DISCUSSION

Though prior observations and personal communications with pest managers in the West had suggested the effectiveness of DFB tree baits, this was the first time we had subjected their effectiveness to side-by-side comparisons between baited and unbaited stands in the field. As a result of this test, we have statistically significant results exhibiting tree bait efficacy. We can now more confidently recommend their use--realizing their effect has been shown in a reproducible field experiment.

The "bait and cut" strategy exhibited in this project should find great utility where DFB populations are causing unacceptably-high tree mortality and logging is an alternative. As shown here, tree baits can be quite effective in containing beetles in infested stands. An added benefit, though essentially an unmeasurable one, may be the likelihood that the baits attract beetles into baited stands from a certain distance away. While that distance is unknown, it may be up to one-half mile where beetle populations are not extremely high. In any case, tree baits are so effective and yet so inexpensive--regardless of the units of "expense" measured: dollars, time, or environmental concerns--we recommend their use become standard practice. Where large-diameter, mature Douglas-fir stands are scheduled for regeneration, and harvesting will be done after beetle flight in a particular year, tree baits should be hung at the recommended concentration (2 per acre) prior to beetle flight. Such practice will have potentially high benefits at almost no cost.

We do, however, issue a single caution for their use. Tree baits should only be used when harvesting is assured. Baiting a stand which is not then removed after beetle flight--and particularly before beetles emerge from attacked trees the following year--will likely result in abnormally-high and undesirably-prolonged tree mortality in that area.

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